VOL. XIV. NO. 10.—BOTANICAL GAZETTE.—OCT., 1889.

Protoplasm and its history.[1]

GEORGE L. GOODALE.

In the department of biology there are three subjects of transcendent interest, namely, protoplasm, or living-matter, development, and adaptation. In fact the interest in some phases of these subjects is now so general and deep that the special students in this department feel that they have to a great extent the sympathy and cooperation of the public at large. This interest renders possible the construction of such commodious laboratories as this, the latest acquisition of the University of Toronto, in which we are now permitted to meet. The generous halls and adequate equipment of this laboratory and other biological laboratories throughout our country and Europe, testify to the existence of a wide-spread belief that the new natural history has very much to learn and much to teach in regard to many of the great problems of life.

In the annual gatherings of the members of our section for the exchange of views and for better fellowship, it has been found expedient for us to look at one or the other of these three subjects at the outset of our work, in a somewhat broad and yet special manner.

Your chairman for the present year asks the privilege of selecting, as his topic for the introductory address, the first of the subjects mentioned. You are invited to examine the more recent additions to our knowledge of protoplasm, restricting the examination to discoveries in the field botany.

Whether we consider protoplasm, or the living-matter of plants and animals, from the point of view of physics, of chemistry, of physiology, or of philosophy, we have before us a topic which has received, and which continues to receive, the most assiduous attention. Hence its literature, though comparatively recent, is appallingly voluminous, and any attempt to treat the subject, or any considerable part of it, exhaustively, within the limits properly imposed upon introduc-

[1]Address delivered by Professor George L. Goodale, of Harvard University, as Vice-President of the Biological Section of the A. A. A. S., at Toronto, August 28, 1889.

tory addresses, would result in annoyance to you and utter discomfiture for me. Apropos of this, I am reminded of a series of experiments upon protoplasm, conducted in a German laboratory, which will illustrate the embarassment which the case presents. The study to which I refer was with regard to certain organisms of very low grade. At a given period in the life of these organisms, their microscopic masses of protoplasm become confluent in such abundance that sufficient material can be procured for experiments on a large scale. In the special investigation referred to, a considerable quantity of protoplasm obtained in this way was subjected to enormous pressure. You can anticipate the result, there remained behind only a shrunken residue of what we may call, without figure of speech, the most juiceless and the driest of husks.

This natural result of extreme compression has stared me in the face during the preparation of the present address. A similar result is more than likely to follow my attempt to bring within very narrow limits the subject which I have chosen for your consideration.

The word protoplasm was coined by Hugo von Mohl in order to designate certain active contents of the vegetable cell.

We shall gain in clearness of vision by letting our glance rest first on the results of investigating vegetable cells and cell contents, anterior to von Mohl's time, in order that we may see some of the steps by which this term was reached by him. The compound microscope was not applied seriously to the examination of the structure of plants until about fifty years after its discovery by Drebbel. In 1667, Robert Hooke, of England, published an account of his investigations of minerals, plants and animals under the microscope, and gave excellent illustrations of what he thought he saw. His first reference to the structure of plants is in his description of charcoal, and this is followed by a good account of common cork. In these brief and fairly accurate descriptions, the author makes use of the word "*cell*," applying the term to the cavities in charcoal and in cork.

Hooke's interesting treatise was soon followed by two remarkable memoirs—one by an Italian, the other by an Englishman. Malpighi, of Bologna, sent to the Royal Society of London, in 1670, a work entitled *Anatome Plantarum*. The published volumes bear the dates 1675 and 1679. At the period these volumes were in the hands of the Royal Society, Nehemiah Grew, secretary of the Society, was engaged

in work almost identical with that of Malpighi, but there is no good reason to believe, as was formerly intimated, that he was indebted to Malpighi for any of the statements which he published as his own. It is, however, best for us to consider these two works together. By Grew the term "cell" appears to have been applied to the cavities in what we may term the softer tissues of the plant. It is certain that neither Malpighi nor Grew recognized, as we can now, the multifarious forms of vessels, fibres, long cells and the like, as referable to a common source. There is always a strong temptation to read in an old text some meaning which squares with our own notions, and one is greatly tempted to think that these assiduous investigators, Grew and Malpighi, detected the relationships which we know exist between the different elements of vegetable structure. But after giving them the benefit of every doubt, one fails to find in their writings any recognition of such affinities. On the contrary, these investigators were engaged in a study which naturally led them away from such conceptions. They were busy with descriptive work, outlining the arrangement of tissues in all organs of the plant which their knives could reach. They did not even break up the tissues into elementary parts, but they described and delineated with great skill the tissues as they were displayed in sections. Is it not incredible that these first works on vegetable structure, prepared only a few years after the earliest application of the compound microscope to the study of plants, should have remained for almost one hundred and fifty years the only comprehensive treatises on the subject? But the most charitable inquirer fails to find, during that long period, any other works of importance on vegetable anatomy.

Near the close of the last century, at a period characterized by activity in many departments of speculative inquiries, the subject of vegetable structure again excited considerable attention, but little substantial advance was made. In 1804 the Royal Society of Sciences at Göttingen proposed for competition certain questions relative to the structure and the mode of growth of tissues. The chief contestants for this prize were Link, Rudolphi and Treviranus. The memoirs of the first two received the prize, that of the latter honorable mention. The names of others should be referred to as having worked at or about this time in the same field, namely: Bernhardi, Mirbel, and Moldenhawer, the latter making a great advance in certain directions. But to all of these whom I have mentioned, including the winners of the prize, the important questions seem to be, how are the structural elements

distributed, rather than how they are related to each other in manner of growth and as respects their origin. With the cell contents they had comparatively little to do. They were busy with the constituents of the framework.

There appears to have been a strong suspicion on the part of some botanists during that period that all this study of the skeleton of the plant failed to go to the bottom of the question. The only wonder is that with their scanty and untrustworthy chemical appliances and with their very imperfect lenses they accomplished so much. May I remind you that the element iodine, which is the most important reagent in the examination of the contents of vegetable cells, was not employed until the year 1812; and, further, that no good achromatic and aplanatic lenses, of even moderately high power, were constructed until 1827.

Noting the more important discoveries of the next period in their order, we come first upon that of the nucleus of vegetable cells by Robert Brown in 1833, and one mode of cell division by Mohl in 1835. In 1838, the eccentric Schleiden published his Contributions to Phytogenesis, in which he states substantially that cells of plants can be formed only in a fluid containing, as chief ingredients, sugar and mucus (*schleim*). By this latter term he designated the nitrogenous matters taken collectively. At his touch all disguises fell, and for the first time the vegetable cell was distinctly recognized as a unit of structure always serving as the common basis for the formation of the innumerable shapes of the structural elements.

Next comes the master, Mohl. Armed with the best optical appliance procurable, familiar with the use of the chemical reagents then at command, and accustomed to accurate research, he reviews his own earlier work and that of his contemporaries, making rapid advance in the knowledge of the contents of the cell. In 1844, in a paper on the circulation within vegetable cells, he speaks of the living mass in each active cell, and distinctly recognizes it as that which is the treasury of stored energy and the vehicle of energy under release. He describes it as that which builds shapely forms out of unformed matter and at first hands. This substance he names *protoplasma*.[2]

[2] "Da wie schon bemerkt diese zähe Flüssigkeit überall, wo Zellen entstehen sollen, den ersten, die künftigen Zellen andeutenden festen Bildungen vorausgeht, da wir ferner annehmen müssen dass dieselbe das Material für die Bildung des Nucleus und des Primordialschlauches liefert, indem diese nicht nur in der nächsten räumlichen Verbindung mit derselben stehen, sondern auch auf Jod auf analoge Weise reagiren, das also ihre Organisation der Process ist, welcher die Entstehung der neuen Zelle einleitet, so mag es wohl gerechtfertigt sein, wenn ich zur Bezeichnung dieser Substanz eine auf diese physiologische Function sich beziehende Benennung in dem Worte *Protoplasma* vorschlage."

If we look at the hand-books of botany just before this date of the early forties, we find references to "coagulable matters" (Treviranus), and the chemical instability of the substance within cells was suspected of having much to do with its activity, but almost all of the notes, as well as those upon the same subject found here and there in philosophical writings of the latter part of the last century, are based on pure speculation. The scientific recognition of a physical basis of vital activity must be credited to Schleiden and Mohl.

The term protoplasm was at once adopted by Schleiden, and a good substitute for the indefinite and misleading word *schleim*, which he had employed to designate essentially the same substance, and it became thoroughly established in scientific terminology. In 1850, Prof. Cohn (and Unger in 1855) showed that the protoplasm of vegetable cells is identical with what had been described, in 1835, in animal structures as *sarcode* by Dujardin, and this prepared the way for the exhaustive treatise by Max Schultze in 1858. From that date on, work in the contiguous fields of botany and zoölogy has made no physical or chemical distinction between the living-matter in animals and plants. Investigators in the two fields have been mutually helpful.

Mohl, in his treatise on the vegetable cell, published in 1851, gives the following account of protoplasm:

"If a tissue composed of young cells be left some time in alcohol, or treated with nitric or muriatic acid, a very thin, finely granular membrane becomes detached from the inside of the walls of the cells, in the form of a closed vesicle, which becomes more or less contracted, and consequently removes all the contents of the cell which are enclosed in this vesicle from the wall of the cell. Reasons hereafter to be discussed have led me to call this inner cell the *primordial utricle* (*primordialschlauch*). * * * In the center of the young cell, with rare exceptions, lies the so-called *nucleus cellulæ* of Robert Brown ('*Zellen-kern*'; '*Cytoblast*' of Schleiden). * * * The remainder of the cell is more or less densely filled with an opaque, viscid fluid of a white color, having granules intermingled in it, which fluid I call *protoplasm*."

We must now pass without notice numerous contributions to the subject and consider Hofmeister's description of protoplasm given in his Vegetable Cell, published in 1867.

"The substance protoplasm, whose peculiar behavior initiates all new development, is everywhere an essentially

homogeneous body. It is a viscid fluid containing much water, having parts easily motile, capable of swelling, and possessing in a remarkable degree the properties of a colloid. It is a mixture of different organic matters, among which albuminoids and members of the dextrine group are always present. It has the consistence of a more or less thick mucus, and is not miscible with water to any great extent."

From these accounts we see that the following points were regarded as established: (1) All of the activities of the vegetable cell are manifested in its protoplasmic contents. (2) Protoplasm consists chemically of a nitrogenous basis. (3) Protoplasm has no demonstrable structure. (4) The protoplasmic contents in one vegetable cell are not connected with the protoplasmic contents in adjoining cells. (5) The nucleus and other vitalized granules in the vegetable cell are formed by differentiation from amorphous protoplasm.

It is now our duty to see in what manner these views have been modified during the last twenty, or rather ten, years. In describing the changes of opinion, time will not suffice for us to allude to most of the observers; a few only can be mentioned by name.

The first thesis, namely, that all of the activities of the vegetable cell are manifested in its protoplasmic contents, may be regarded as firmly established. It is at this point in our present examination when, if we had time, we should take up, one by one, the terms which have been applied to some parts of what Mohl and Hofmeister knew as protoplasm. But we can only glance at them in passing: Thus, *cytoplasma* is understood to be the mass exclusive of the granular contents of all kinds; *hyaloplasma* is the outer hyaline layer; *polioplasma* is the grayish granular part. To these terms may be added others, such as *paraplasma*, etc.

The second thesis, viz., protoplasm consists chemically of a nitrogenous basis, remains unchanged. But, instead of regarding the protoplasmic basis as comparatively simple, it is now known to be exceedingly complex, and to contain numerous cognate proteids, some of which can be identified in the basic mass, others in the nucleus, and others still in the vitalized granules.

These researches must be considered also with reference to those by two active investigators, Pfeffer and de Vries. The former has shown the conditions under which active protoplasm reacts in the presence of certain chemical ex-

citants, the latter has demonstrated the relations of a part of this irritability of protoplasm to its physical constitution. But, as a result of all these recent studies, it becomes more and more clear that the chemical relations of the protoplasmic activities are still veiled in mystery. Botanists are receding from a position held by many only a few years ago, namely, that it is safe to use the words albuminoids and protoplasm interchangeably; nowadays the latter term is generally restricted to morphological and physiological conceptions, the former keeps its wide chemical significance.

Just here come in the chemical studies of protoplasm; by Rodewald and Reinke on a large scale, by Loew and Bokorny, and by Schwarz under the microscope. All of these results compel us to recognize in protoplasm a substance of bewildering complexity of composition and constitution. Moreover, you all know how wide this field of research has suddenly become by the discovery that different microbes (which are, essentially, minutest masses of protoplasm) not only give rise to such diverse products, among others the ptomaines, but present such diverse chemical reacitons.

Protoplasm is no longer regarded by any one in any sense as a comparatively simple substance.

The third thesis, namely, protoplasm has no demonstrable structure, has been modified in a striking manner as a result of improved appliances for research. By better methods of staining, and by the use of homogeneous immersion objectives, the apparently structureless mass is seen to be made up of parts which are easily distinguishable. There has been, and in fact is now, a suspicion that some of these appearances, under the influence of staining agents, are post-mortem changes and do not belong to protoplasm in a living state. But it seems to be beyond reasonable doubt that protoplasm is marvellously complex in its morphological and physical as well as its chemical constitution. One statement of the case is as follows:

Under ordinary circumstances, protoplasm is composed of a mesh of inconceivable fineness, in which mesh are entangled the more liquid interfilar portions (paraplasma); so that the dry husks left in Reinke's experiment may be regarded as the residue of network from which all the moisture has been expelled. But this conception of protoplasm as a mass composed of a network of minutest fibers enclosing in the meshes another substance, presents, as has been well shown by some critics, great difficulties when we endeavor

to explain the movements within the cell. It is very difficult to explain in any way the so-called wandering of protoplasm outside the cell wall or into intercellular spaces.

Fourth, we are to glance at the accepted statement that the protoplasmic body or protoplast, as it is called, of one cell is cut off by the cell wall from all connection with the contiguous cells. There are a few cases in which this intervening wall was formerly held to be pervious, but such cases were considered as exceptional. Now, however, as has been shown by Gardiner and others who have followed out his exact researches, there are intercommunicating threads of protoplasm of extreme fineness between adjoining cells, and these living threads maintain connections, sometimes direct, sometimes indirect, between one protoplasmic mass and another. This has been shown to be so widely true in the case of the plants hitherto investigated, that the generalization has been ventured on, that *all the protoplasm throughout the plant is continuous*. The formation of the dividing wall in cell division is now better understood than ever before, and our knowledge of this process lends great probability to the truth of the general statement made. It is not unlikely, then, that all the living-matter throughout each plant is continuous, a whole, shut off at the time of severing from the mother plant from the body of protoplasm there, and thus making a true chain of descent.

May I ask you to observe, in passing, how this bears on the vexed subject of individuality of plants. Brücke, in 1862, declared that the living protoplasmic contents of a cell formed an elementary organism, and this idea found its fullest expression in the profound work by Hanstein in 1880. In that treatise Hanstein proposed for the living protoplasmic contents of the cell the term protoplast, in order to indicate its individuality. But these late researches show that these protoplasts are not only highly organized and of complicated structure, but each is bound by indissoluble ties to its nearest neighbors, each helping to form a united whole.

The fifth thesis has been completely controverted. Instead of believing, as formerly, that all the granules within the cell arise *de novo* from the protoplasm in which they are imbedded, we are now forced to regard all of them as springing from pre-existent bodies of the same character.

Hofmeister, in 1867, in an exhaustive description of the contents of vegetable cells, states distinctly that the nucleus arises from homogeneous protoplasm, and that in all cell

division the nucleus must first disappear, two new ones arising in its place. The nucleus occupied a secondary place as a derivative organ. And the chlorophyll granules were believed by him and his contemporaries to be new formations from homogeneous protoplasm under certain conditions of light, temperature and food. Researches, which leave no room for doubt, have shown that the nucleus, in all cases hitherto examined, springs from a pre-existent nucleus by a process of division. The process of division, with its marvelous sequence of formal arrangements of definite portions in meridional lines and in polar and equatorial masses, has been most carefully examined in almost every organ of the plant, and in connection with similar processes of cell-division in animal tissues. In no well marked case has a nucleus been observed to arise from homogeneous protoplasm, even a few doubtful instances having been lately explained satisfactorily.

The extraordinary manner in which the nucleus, both in common cell-division and in reproductive blending, carries ancestral characters and controls the distribution of nutritive materials, is as yet the greatest mystery in vegetable life.

We pass next to consider a very important change of view in regard to the other granules imbedded in the protoplasmic body, known as leaf-green or chlorophyll granules. Formerly, as we have noticed, it was held that all of these sprang by a process of differentiation from the shapeless mass in each exposed cell. Researches by Schmitz on some of the lower plants, and by Schimper and Meyer on the higher, have shown beyond any reasonable doubt that these chlorophyll granules always arise by a process of division from pre-existent granules. But this fact, taken by itself, might not possess great interest. It is, however, known that at the growing points where leaves are developed, the cells contain in their protoplasm granules of about the consistence and color of protoplasm itself, and these granules have the power of division, much after the fashion of the cell nucleus. But the products of such division are essentially three-fold; some of the resulting granules are colorless, like the mother granules, others become true chlorophyll granules, while others still, in those leaves which become the leaves of the flower and the fruit, assume colors other than green. In other words, we have in these associated granules, or chromatophores, a morphology which is of the highest interest. The

needs of the plant bring from this common source the microscopic organs for assimilation, for storing up starch in the form of grains, for protection and attraction. This most interesting generalization in regard to the granules taken together, adds a new zest to the study of the developing plant and the evolving species.

It has been lately claimed by de Vries of Holland, that the sap-cavities or vacuoles in protoplasm divide in much the same way as do the granules just referred to, but this part of the subject is not yet beyond all doubt. That the sap cavities are the birthplace of most crystals, and that the aleurone grains may be desiccated sap cavities has been made out by several observers. But it is not clear that vacuoles divide as granules do. What we do know beyond all reasonable question is this—that all the working granules within the plant have sprung from pre-existent granules, and that there is no break here in the transmission from parent to offspring.

Such, then, are some of the more important changes which have taken place with regard to our knowledge of the living contents of vegetable cells. I would gladly take the time, if it could be granted, to call your attention to certain most interesting discoveries which have been made by Pfeffer relative to the absorption of coloring agents by living protoplasm, and which have been supplemented by Campbell in regard to the nucleus. But more than this allusion is now impossible.

It is an interesting coincidence that with the substitution of the crude compound microscope for high power simple lenses in 1660, came the first works on vegetable structure, and for more than one hundred years, or until the introduction of achromatic object glasses, these works were in truth the only authoritative treatises. With the introduction of water-immersion lenses came renewed activity in this field, and with the later discovery of homogeneous immersion lenses came the results which have now been detailed. Whether we have, at these stages, more than a series of interesting and very striking coincidences, or not, we have not time now to discuss. It is enough for our present purpose to observe that, with the introduction of the cedar oil immersion objectives, a thorough reinvestigation of certain parts of this subject began. One may be pardoned for asking whether the objectives known as apochromatics are to open up in this field new lines of research.

Can these recent discoveries relative to the continuity of

protoplasm and the genetic relationship of the associated granules (including, in the widest sense, the nucleus), be made to cast any light on the question of development, as they certainly do upon the kindred question of adaptation? The answer has been given us very lately by Hugo de Vries of Amsterdam. This investigator, who has done very much to clear up certain obscurities in regard to the external relations of the cell, has recently revised the neglected doctrine of pangenesis and applied it to the question just propounded. De Vries suggests that we divide the hypothesis of pangenesis as proposed by Darwin into two parts, as follows: (1) In every germ-cell individual characters of the whole organism are represented by material particles which, by their multiplication, transmit to descendants all of such peculiarities. (2) All the cells of the organism throw off, at certain periods of development, such material particles, which flow towards the germ-cells, supplying its deficiencies. Now de Vries asks whether it is not high time for us to look at the first part of this hypothesis again, and abandon the hindrances which the latter part imposes. If we accept his suggestion, and restate the hypothesis, in view of what has been learned relative to the nucleus and other granules (the trophoplasts) within the cell, we should then read:

In every cell at a growing part are all the elements ready for multiplication. Each protoplast possesses the organs necessary for continuous transmission; the nucleus for new nuclei, the trophoplasts for new granules of all kinds according to the needs of the plant.

The author reviews the theories bearing on the question from the so-called plastidules of Elsberg to the germ-plasma of Weismann, and then applies his hypotheses of intra-cellular pangenesis to the different parts of a single plant and to the transmission of peculiarities. The active particles recognized in Darwin's hypothesis he terms *pangens*, and, regarding them as vehicles of hereditary characters, traces them throughout their course. He is not obliged to ask for any means of transportation for these pangens, for they work, so to speak, on the spot. They are ready at hand at the points of growth. We must look very sharply with reference to this at two points of growth in the flowering plant, namely: the bud and the seed. Each bud, with its growing point made up of cells containing in their protoplasm the divisible granules, carries with itself all the peculiarities which have been transmitted without appreciable change. In the formation of the

bud there is fission, but no blending. The cells divide, and each new one may in turn divide until the ultimate form of the leafy branch or flower is reached. In the leafy branch new buds form, and in their turn carry forward the ancestral peculiarities. But in the flower, on the other hand, with the formation of the ovule, all development is arrested (except in the rare cases of parthenogenesis and the like) unless the protoplasm of the embryonal sac receives a new impetus from material contributed by the pollen grain. And in this blending of parts which have developed under different external conditions, we see that there is a chance for variation to come in. Not only is there a blending of the nuclei, but a sharing of the accompanying trophoplasts. How this can be applied to the lower plants and other organisms can not now be referred to. It would not be right to hold de Vries wholly responsible for the application just given, but I ask you whether the hypothesis does not appear fruitful. It seems likely to stimulate speculation and further research in this important field.

In view of de Vries' work, and of the results of recent study, which I have endeavored to bring before you this afternoon, does not the statement of Darwin possess new force?

"An organic being is a microcosm, a little universe formed of a host of self-propagating organisms inconceivably minute and as numerous as the stars in heaven."

Cambridge, Mass.

Paraguay and its flora. II.

THOMAS MORONG.

It would be out of place in an article like this for me to attempt to enumerate even a tithe of the trees found in these dense Paraguayan forests, but among those best known abroad are the India-rubber (Siphonia elastica), Erythroxylon Coca, logwood (Hæmatoxylon Campechianum), Salix Humboldtii, Carica Papaya, Quillaia saponaria, Fabiana imbricata, Nectandra, Franciscea uniflora, the Omber (Pircunia dioica), and Juga dulcis. Something of their character and numbers may be seen in the collection of her woods which Paraguay has sent to the present Exposition at Paris. The collection is in part composed of one made several years since for a similar exhibition at Montevideo, to which large additions have been made by Dr. Emile Hassler, who has

charge of the matter. The specimens, which have been carefully prepared in sections so as to show the bark and the interior fiber of the wood, together with many thin squares polished and framed, number in all 233 different species. To these Dr. Hassler has added specimens of charcoal made of different kinds of wood, 93 specimens of trees, shrubs and herbs which are used for medicinal purposes, 38 that yield textile fabrics, 8 of them furnishing vegetable silk, and 25 from which excellent materials for coloring and dyeing are obtained. Few countries of the size of Paraguay, which scarcely equals the state of Colorado[1] in area, could make such an exhibition. Brazil is probably the only South American country which could surpass this little territory in this respect.

In table supplies Paraguay is hardly surpassed by any nation on the globe. To say nothing of the ordinary garden vegetables, nearly all of which are easily cultivated in her fertile soil, she has of fruits the orange, the lemon and the citron, all growing here to perfection and without culture; the fig, banana, pine-apple, peach, grape, guava, papaw, water-melon and musk-melon, both of fine quality and raised with scarcely any care; the cocoa-nut (that is, the small cocoa-nut mentioned above, which is very edible), pea-nut, sterculia-nut (similar to cocoa), and many other wild fruits for which there are no popular English names. Of other valuable productions she furnishes the far-famed Yerba-maté (Ilex Paraguayensis), a tea drank by eighteen million people in South America, the best and by far the greater part of which grows wild in her eastern Cordilleras: coffee, as good as that of Brazil; cotton, equal to any upland cotton of the United States; tobacco, which is raised in large quantities; mandioca or cassava, regarded with good reason as an excellent substitute for wheat flour; maize or yellow corn, grown abundantly by the farmers; sugar-cane, of the best quality; sorghum, Irish and sweet potatoes and yams, rice, the egg-plant, and many fine pasturage grasses. We must take into the account, too, that this country is agriculturally yet in its infancy. The farming is very limited, and at best of the poorest sort. The conditions are all favorable for raising nearly everything which can be grown in a semi-tropical climate, and I have no doubt that in time scores of other fruits and vegetables will be success-

[1] Paraguay has an area of about 100,000 square miles, while Colorado has over 104,000 square miles of territory.

fully introduced from abroad into this well-watered, sunny and fertile land.

The most prolific order of plants found here is, of course, the Compositæ, as it is in all other countries. Many members of the order, however, are shrubs, some even attaining the stature of trees. Others possess a floral structure which is very strange to a botanist from the United States. One of them has four small, inconspicuous, deciduous staminate flowers right in the center of the receptacle, which are surrounded by a row of large achenia surmounted by hooked spines and small corollas, and becoming in fruit sharp-thorn burrs that are a great nuisance. Another large and succulent plant bears along the upper side of its curving stems rows of the most beautiful variegated green and white rosettes, looking as if made in a milliner's shop for a lady's bonnet. Still another species has conglomerate heads, the outer involucre consisting of three large foliaceous scales, and within many separate bundles of heads, each bundle furnished with a set of scales, and each head with its own proper scales. I have found several species which bear these peculiar compound heads. The strangest of all is a composite which has only one sheathing involucral scale. Perhaps, however, as the scale bears five small lobes at the summit, it may be said that five scales have so completely coalesced as to appear only one. This flower runs all to 5's. The involucre has five lobes, and also five rows of curious yellow glands sunk beneath its surface. There are five flowers in the head, five pappus scales, five lobes to the corollas, and five stamens. Besides, it is stipulate: the stipules consisting of three-branched, and sometimes of five-branched hairs. Some of the composites have leaves with a a curious margin not described in the books, bearing at intervals lunate indentures or depressions, each with a corresponding brownish lunate gland, sunk below the surface of the leaf, a short distance beneath it.

The Leguminosæ rank next in number to the Compositæ, presenting innumerable species of Acacia, Mimosa, Cassia, Phaseolus, and other genera. Then come the Asclepiadaceæ and Bignoniaceæ, many of which, perhaps the most, are lianas that clamber our shrubs and trees, with conspicuous flowers and fruits. Of the former, two species have interested me exceedingly. They belong to that curious South American genus, the Araujia. Some of the readers of the GAZETTE may remember an article in the *American Nat-*

uralist, by E. C. Stearns, which was quoted in the *Popular Science Monthly* for March, 1888, in which the writer describes the moth-catching propensities of A. albens, a native of Buenos Ayres. I think that all the species of Araujia are moth catchers. At least one of those that I have collected here is so, of which I had an interesting illustration. This species differs a good deal from A. albens. It bears axillary clusters of fragrant white flowers, the corollas of which have long segments that are twisted spirally about each other somewhat like the arms of a boy's paper windmill. The first time I came across this plant I found a large humming-bird moth imprisoned by a flower, and struggling desperately to get free, but in vain. It had thrust its proboscis into the flower in search of honey and was utterly unable to withdraw it, although a very powerful insect, in fact, as large as one of the smaller humming-birds, which it much resembles. I intended to keep the insect in place, dissect the flower, and ascertain just how it was confined, which I confess I do not understand, notwithstanding the description of Mr. Stearns, but in plucking the flowers I accidentally liberated the moth and so lost the opportunity of investigation. Another species here is a very conspicuous climber, with large, solitary, axillary and fragrant blossoms, and an immense spine-covered fruit almost as large as a cucumber.

The Bignonias are some of them tall trees, and others climbing plants, usually with showy flowers, very long pods, and winged seeds. They generally blossom late in the year, many of them adorning the forests in the winter season. Nearly every thicket abounds with climbers of various kinds, some of which mount to the tops of the tallest trees, choking and finally killing them with their exuberant growth. Indeed, vegetation here is so prolific that it is difficult to penetrate the thickets without a hatchet or axe in hand. Trees and shrubs, vines and runners, crowd into every available foot of space, and one must wind through them like a fox or a squirrel. The shade within is so great that a person can scarcely pick his way along. Fallen trees obstruct the course at every step, and a road or path unused for six months becomes so covered with new growths and decaying logs that it is impassable. Even traveled highways and railroads have to be cleared almost monthly of the vegetation which constantly encroaches upon their borders.

Nor is this the only difficulty which a botanist experiences

in herborizing in Paraguay. If he succeeds in capturing rare botanical treasures, he can not do it without much trouble. He either runs the risk of broken limbs in the attempt to climb high trees, or of sore wounds if he incautiously catches hold of a shrub or a liana. Nearly every arborescent plant is armed with stout, sharp thorns, which tear his clothing and very likely something else more sensitive than cloth. Here is a lovely Acacia, with bright yellow blossoms, which I covet, but in an instant it has caught my coat at a dozen points with its keen hooked spines. If I attempt to tear myself away, lo! several great rents in my coat, and unfortunately no fireside companion at hand to make the rents whole again. If I cut off a branch with a jerk of the knife, half a dozen deep gashes in my hand is the result. Here is a beautiful climber, the flowers of which I must have, but in order to get it, not only must I encounter the spears of a host of encircling Yuccas and the prickles with which the climber is itself clad, but I must also break through the spiny armor of an Acacia, around which the stems have managed to twine themselves so closely that they can scarcely be touched at a single point without a wound. Again, I see a beautiful shrub, of I know not what genus, which bears a large evergreen leaf and handsome clusters of rose-colored Camellia-like flowers. I hasten to transfer specimens to my portfolio, but hidden under the bright leaves and charming flowers is a stem bristling at intervals of a few inches with verticils of branching prongs, an inch and a half in length and as sharp as needles, and what is even worse, these needles infuse a poison into the wound which they make and cause it to fester.

Other plants harbor colonies of ants, by which they seem to be benefitted, or, at least, protected, and if you dare invade their premises they resent it instantly and pour forth in angry swarms. Nor is their bite to be despised. I once plucked a stalk of grass from the ground, and before I could place it in my portfolio my hand was covered with small red ants, whose stings burned like hot coals. It was the "fire ant," insignificant enough in looks, but so venomous of sting that every one avoids it. Other colonies climb trees, and with plasters of mud convert old birds' nests into habitations, which it is really quite dangerous to molest except with lighted matches. On another occasion, while leaning down to collect plants, I happened to place my hand against the trunk of a dead tree, but a sharp stinging sensation soon warned me that my hand

was resting upon something besides dead wood. It was the home of a colony of what is called "soldier ants," an insect nearly half an inch long and with a round black head which seems to be one-third the size of its body, and armed with formidable forceps. In a spirit of spitefulness, I took a stick and broke their nest to pieces, and so fierce were the creatures that they attacked my stick viciously, and doubtless would have bitten me to death could they have reached me. Plants which are defended by such ants and also by large red wasps, hornets and spiders, which make their home upon them, are not to be touched with impunity. A wasp whose bower I had entered in search of specimens, stung me so severely that I was glad to retreat with the most unceremonious haste.

Other plants are guarded against mutilation in a different, but perhaps none the less effective, manner. They pour out a copious discharge of acid, milky juice, which sometimes raises a blister upon the skin, and is always unpleasant to encounter. An Asclepiad growing near Asuncion, from which I cut branches, discharged such large drops of viscid milk upon my hands and clothing that I wished I had let it alone, and the specimens adhered to the leaves of the portfolio and the sheets of drying paper as though they had been smeared with postage-stamp mucilage. On another occasion, while making my way through a dense wood, I heard a pattering like the falling of rain-drops. As it was a bright, sunshiny day, I was curious to learn the cause of the sound. Upon investigation, I found that it was occasioned by drops of milk, which were falling in a shower from the leaves of a large tree. The ground was quite white with the drops. Many cattle were grazing in the vicinity, but I noticed that they scrupulously avoided this tree, and never browsed upon its leaves, although they ate almost everything else within reach.

The greatest obstacle to the preservation of botanical specimens lies in the excessive humidity of the climate. The atmosphere seems to be loaded with vapor at all times, even in the most cloudless weather. The average annual rainfall at Asuncion, and probably that of Paraguay in general, is about 70 inches. Some scientists estimate it as high as 80 inches.[2] This year, according to meteorological statistics kept by government, the rainfall has been a little more than 70 inches. With such an amount of humidity in the air, of

[2] Notes of a Naturalist in South America, by John Ball, p. 299.

course many things will mould in spite of the utmost care. It must be remembered also that the houses are built of brick, one story in height, with brick floors, and entirely without appliances for obtaining artificial heat, so that they are always damp. My books, shoes, leather straps, paper and presses, and even my wearing apparel, are generally more or less moist when not exposed to the sun. Specimens dried in the sun are sure to become damp and limp during the night and in rainy and cloudy weather, which sometimes lasts for several days. Added to this is the natural tendency of many plants to drop to pieces in the process of curing. The new-comer, good easy soul, naturally supposes that, with such a hot sun, his specimens are sure to dry easily and quickly. Experience will soon convince him to the contrary. Take this shrubby Ipomœa, which is very common in the lowlands around Asuncion. The flowers are as large and showy as those of a morning-glory. Let the collector place specimens in the best order between his driers, and change them every hour if he chooses. In less than three days he will have the pleasure of seeing flowers, leaves and buds, all disarticulated. I worked over scores of specimens of this plant. I tried every expedient that I could devise, took pains to get young and fresh plants, split the stems in two, exposed them to sun heat: but all in vain. I have never succeeded in preserving over half a dozen specimens in which the leaves or flowers adhered to the stem. Take this pretty little red-flowered papaveraceous plant, and carefully arrange that in your press. In three weeks it is just as juicy as ever, and, still worse, there is nothing left of it but fragments. The floral organs have fallen to pieces, petals, sepals, styles and all, and only *disjecta membra* lie on the paper, leaving a bare stem, and perhaps even that has become dismembered with the rest. Here is a lovely Commelyna, which I wish to send home to delight North American eyes. The corolla is large, of a bright azure blue. I put that in press, and in an hour's time look at it. In that short period the petals have apparently been converted into a little pool of water! Like the manufactured thing here which they call *ice*, a piece of which dissolves while you are pouring water into the tumbler, so this charming flower has *melted!* All that is left of the petals when dried is a small, shrivelled, membranous heap which hardly wears the aspect of a flower. The stem and leaves, however, make up for the evanescence of the corolla, for they will keep green and succulent for six weeks under pressure.

Of course, a zealous and persistent botanist will surmount all these difficulties in one manner or another, but it will be seen from my account that it is no easy task to collect and preserve the members of the Paraguayan flora. Begonias, which abound here, and other succulent plants, are exceedingly difficult of management. Some plants, like the Calamus, can not be dried in any decent shape, and others, like the Victoria regia and several of the Cacti, can not be preserved at all. They will mould or rot in despite of every expedient. Many specimens must be preserved, if at all, in fragments, and pieced together upon the mounting paper.

Notwithstanding all this, I have managed to get together about 750 species and some 8,000 specimens, which I trust will be in a sufficiently good condition when they get home to be identified and to make a valuable addition to the herbaria of the United States.

Asuncion, Paraguay.

The grasses of Roane Mountain.

BY F. LAMSON SCRIBNER.[1]

Roane Mountain, lying on the border line between Tennessee and North Carolina, has been made famous as the botanizing ground of some of our best botanists, including even Dr. Gray, who first visited it in 1841, and its flora possesses a peculiar as well as a historical interest. In the old register of the hotel are recorded the finds of the several botanists or botanical parties who have visited the locality. The first of these was made in 1878 by Dr. Geo. Vasey, who, under the head of "Grasses of Roane Mountain," enumerates the four or five species observed by him.

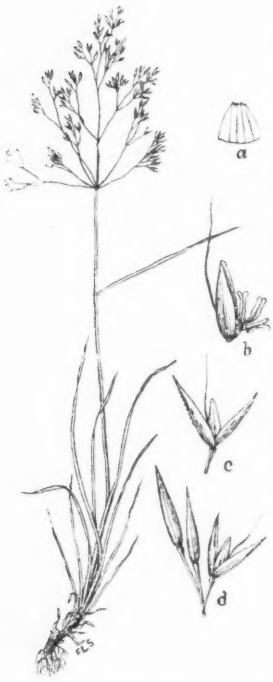
As the guest of Mr. C. M. McClung, a prominent business man of Knoxville, Tennessee, and an enthusiastic student of North American plants, I spent a few of the last days of July of the present season upon the mountain, and improved the occasion by investigating the grasses of the locality. As the result of three days' rather diligent search, we together found on or near the mountain summit (all at an elevation of over 6,000 ft. above sea level) twenty-five species, of which the following is a list:[2]

[1] Read before Section F, at the Toronto meeting of the A. A. A. S. 1889.

[2] I have already, in a paper read before the Society for the Promotion of Agricultural Science at the Toronto meeting, considered the grasses of this region from an agricultural aspect.

Phleum pratense L.
Agrostis perennans Tuck.
" scabra Willd.
" rupestris Chapm. [3]
" alba L.
Cinna pendula Trin.
Brachyelytrum aristatum Beauv.
Calamagrostis Canadensis Beauv.
Dactylis glomerata L.
Eatonia Pennsylvanica Gray.
Glyceria elongata Trin.
Poa annua L.
" compressa L.
Poa pratensis L.
" alsodes Gray.
Festuca elatior L.
" nutans Willd.
Bromus ciliatus L.
Elymus striatus Willd.
Asprella Hystrix Willd.
Danthonia spicata Beauv.
" compressa Austin.
Trisetum subspicatum, var. molle Gray.
Deschampsia flexuosa Griseb.
Holcus lanatus L.

Some of these species had evidently been introduced, for example Dactylis glomerata, Festuca elatior, Phleum pratense and Holcus lanatus, but all among those not natives, excepting the orchard grass and tall fescue, were well established. Deschampsia flexuosa, growing in exposed situations on rocks and ledges, was one of the most conspicuous and showy species. Poa annua was everywhere along the roads and walks and about the hotel. Poa pratensis and P. compressa were quite generally distributed, and so were the several species of Agrostis, excepting A. rupestris which was found only at High Bluff about a half mile southwest from the hotel. Glyceria elongata was seen growing rather abundantly along a stream near the mountain summit and I mention it particularly to call attention to the fact of the discovery of this northern grass within the southern states. For the same reason I would speak of the finding of Trisetum subspicatum var. molle. Poa alsodes, found several years ago on Black Mountain by Mr. Wm. M. Canby, was seen at several points, but not in any quantity. Danthonia spicata occupied its usual station in dry soil



Agrostis rupestris Chapm., figured from specimen from Roane Mt., N.C. *a*, apex fl. glume; *b*, floret; *c*, spikelet; *d*, group of three spikelets.

[3] This is the *Agrostis rupestris* of Chapman's Flora, but its identity with the plant of Allione may be questioned. The same form occurs on the mountains of New England.

along the ridges and bluffs. Danthonia compressa, distinguished by its greener color, much longer and more abundant leaves, taller culms, more elongated panicles and especially by the longer teeth to the flowering glumes, was the most abundant species of all and the chief component of the luxuriant and dense turf covering the extensive meadows of the treeless areas on the mountain top. The abundance of this grass and the excellent condition of the cattle grazing on it clearly showed its importance as a forage plant. It is a species found along the mountains from the Carolinas and Tennessee to New England, and wherever it grows abundantly yields excellent fodder for horses and cattle. A cool climate and abundant atmospheric humidity are apparently essential to its best growth.

Another species of Danthonia, viz., Danthonia Californica, especially the variety unispicata, occupies a similar position with respect to its abundance and value for forage, in the mountain meadows or "deer parks" of the Rocky Mountains in Montana.

The principal native fodder grasses of the high mountain meadows, or as they are familiarly termed in the west, "deer parks," are:

For the Alleghanies:
Danthonia compressa Austin.
For the Rocky Mountains in Montana:
Danthonia Californica var. *unispicata* Thurb.
Danthonia intermedia Vasey.
Festuca scabrella Torr.
Alopecurus occidentalis Scribn.
For the mountains of Arizona:
Poa Californica Vasey.
Muhlenbergia virescens Trin.
Muhlenbergia gracilis Trin.

Knoxville, Tenn.

Pickerel weed pollen.[1]

BYRON D. HALSTED.

The flowers of the pickerel weed (*Pontederia cordata* L.) are strictly trimorphic, as was determined by Mr. W. H. Leggett in 1875. There are six stamens in each blossom, placed in two sets of three each, and a single style. The

[1]Read before the Botanical Club of the A. A. A. S., at the Toronto meeting, 1889

shortest set of stamens is near the base of the corolla tube, and the anthers are not in the same plane, a condition due perhaps to the confined space. A similar variation is, however, found in the other sets of stamens without the same apparent reason. The anthers of all three sets are practically of the same size and color, and might be easily mistaken for each other when the filaments are removed. As in all truly trimorphic flowers, there are six possible kinds of pollen and eighteen combinations of pollen with the stigmas. There is a remarkable range in sizes of pollen, but only three prevailing dimensions, as the following table shows in micro-millimeters:

		Dry.		Wet.
Long stamens:	Short style,	22.4 × 57.6	—	44.8 × 54.4.
	Mid style,	25.9 × 51.2	—	44.8 × 57.6.
Mid stamens:	Short style,	19.2 × 42.6	—	32. × 41.6.
	Long style,	25.6 × 51.2	—	35.2 × 44.8.
Short stamens:	Mid style,	12.8 × 28.8	—	25.6 × 28.8.
	Long style,	12.8 × 28.8	—	25.6 × 28.8.

By averaging each set, we have:

	Dry.		Wet.
Long stamens,	24.1 × 54.4	—	44.8 × 56.
Mid stamens,	22.4 × 46.9	—	33.6 × 43.2.
Short stamens,	12.8 × 28.8	—	25.6 × 28.8.

The measurements of the dry and wet pollen indicate a great change in size and shape when water is added to the dusty pollen as it comes from the dehisced anthers. When dry it has two sutures in the outer coat and resembles a wheat grain in general appearance, but upon the application of water the inner wall enlarges, expands between the two slits in the outer wall, and the grain becomes elliptical or nearly spherical.

Referring to the table of averages it will be seen that the measurements for the short stamen pollen are about half of those for the grains from the longest stamens, and if the size of the smallest pollen, when wet, is represented by $3 \times 3\frac{1}{2}$ inches those of the largest will be 6×7 and the corresponding relative size of the mid stamen pollen is $4\frac{1}{2} \times 5\frac{1}{4}$, or a half of the sum of the figures for the extreme forms.

Three sizes of moist Pontederia pollen.

By glancing at the relative sizes of pollen in other trimorphic plants, as recorded by Darwin and others, it is found for—

Lythrum Salicaria, as 10 — 7 — 6, or 100 to 60.
Nesæa verticillata, " 13 — $9\frac{1}{2}$ — $8\frac{1}{2}$, " 100 " 65.
Oxalis speciosa, " 16 — 13 — 11, " 100 " 69.
Oxalis Valdiviana, " $8\frac{1}{2}$ — 7 — 6, " 100 " 71.
Oxalis Rignelli, " 9 — $8\frac{1}{2}$ — 7, " 100 " 78.

In a trimorphic Pontederia discovered by Fritz Müller in Brazil, the relative sizes of pollen as determined by Darwin[2] are 16—13—9, or 100 to 55. Our own species, therefore, by reducing to the same terms, is as 100 to 54, which accords to Pontederia cordata the greatest range for pollen that has yet been found in any flower.

The variation of pollen among dimorphic flowers does not approach this, as the following short table of the most striking illustrations shows:

Forsythia suspensa	as 100 to 94.
Pulmonaria angustifolia	" 100 " 91.
Polygonum Fagopyrum	" 100 " 82.
Pulmonaria officinalis	" 100 " 78.
Phlox subulata	" 100 " 75.
Primula vulgaris	" 100 " 71.
Primula veris	" 100 " 67.

When the contents of the pollen grains are taken into consideration it is seen that those of the largest stamens of Pontiderìa cordata are to those of the smallest as 8 to 1. Mr. Leggett[3] was aware of this remarkable difference at the time of his study of the flowers, but he was in doubt as to the smaller being perfect. To throw some light upon this point six small wells in an artist's slab were filled with sugar solution, and into two of them the largest pollen was placed—one lot from flowers with mid styles and the other from a short-styled form. A corresponding set was made for each of the other sizes of pollen. The largest grains germinated with the greatest promptness and vigor, and the tubes were naturally much broader and in every way larger than with the smallest sized grains, which as above stated contained only one-eighth as much of substance. There was no observed difference in pollen of the same set of stamens from flowers with different lengths of styles, and all sizes were equally able to germinate when sufficient time was given. The largest pollen tubes need to penetrate a style nearly an inch in length, while the short styles are exceedingly short. As far as I know it is invariably true with both dimorphic and trimorphic plants that the longest grains are borne by the longest stamens, and designed for the longest styles. Therefore, other things remaining constant, the length of style may be an index of the size of the pollen.

New Brunswick, N. J.

[2] Different forms of flowers on same species, p. 186.

[3] Torrey Bulletin, Nov. 1875.

Botany in the American Association.

The following papers were read before the Biological Section of the A. A. A. S. at Toronto:

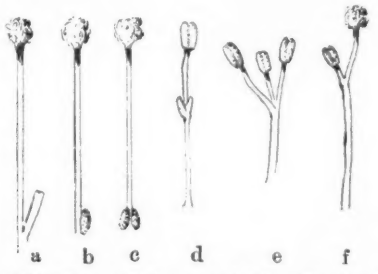
On the position of nectar glands in Echinops, by THOMAS MEEHAN.

The comparatively long corolla tube is quite filled with the style, leaving no passage for the tongues of insects. The nectar glands, however, instead of being at the base of the tubes as usual, are at the top. This arrangement permits the nectar, which is very abundant, to be taken by short tongued insects. The plant has recently come into cultivation for bees.

Section of flower of Echinops.

On the epigynous gland in Diervilla, and the genesis of Lonicera and Diervilla, by THOMAS MEEHAN.

At the base of the style in Diervilla there is a large gland (*a*), the significance of which has not been explained. In Lonicera there is a small gland (*b*) readily overlooked, or rather a pair of glands (*c*.) Careful inspection will also show the gland in

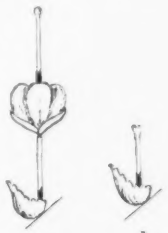


Style of Diervilla *a*, and stamens and styles of Lonicera *b* to *f*.

Diervilla to be double. In the cultivated honeysuckle, L. sempervirens, there are rudiments of glands (*d*), and in a monstrous form these are replaced by stamens (*e*). An instance was once seen of a stamen borne laterally upon the style (*f*). From this series of forms it seems clear that the glands in Lonicera and Diervilla are really rudimentary branches.

On the assumption of floral characters by axial growths in Andromeda Catesbæi, by THOMAS MEEHAN.

This species has been considered diœcious. What has been taken as a flower (*a*) with abortive stamens in the sterile plant is shown by comparison with the corresponding parts of a fertile flower (*b*), to be only the pedicel with petaloid bracts at its base.



a b

Floral parts of Andromeda Catesbæi.

On the significance of diœcism as illustrated by Pycnanthemum, by THOMAS MEEHAN.

The author observed that plants of P. muticum, with apparently perfect flowers, produced no seeds, while plants growing near P. lanceolatum, evidently without stamens, were well provided with seeds. As no other plants of these species grew in the vicinity, it seems to be a case of hybridism. This was used to illustrate the author's belief that hybridism is not a factor in evolution, but a conservative force in heredity, and that diœcism does not favor the evolution of forms, but acts as the handmaid of heredity, to bring back toward the normal condition forms that have wandered.

Some physiological traits of the solid-stemmed grasses and especially of Indian corn, by F. L. STEWART.

The author had ascertained by several seasons' experiments that when corn has the ears removed at the time the kernels are hardening, that the life of the plants is greatly prolonged, and the sugar in the stock much increased. The economic bearing of this fact was indicated.

On the genus Eleocharis in America, by N. L. BRITTON.

There are about forty North American species, of which thirty-six belong to the United States. E. pygmæa and E. pauciflora are excluded from the genus. No new species are made.

On the tropical distribution of certain sedges, by N. L. BRITTON.

The abundance of species in different genera in the new and old worlds were compared, and also to some extent their boreal and austral distribution.

On the flora of New Jersey, by N. L. BRITTON.

Giving some account of the collection of data for the compilation of the final report on the flora of the state, which is soon to be issued.

The new botanical laboratory of Barnard College, by N. L. BRITTON.

This is the annex for women to Columbia College, to be opened in October. The botanical department is under the general supervision of Dr. Britton, but the students will be in the immediate charge of Miss Emily L. Gregory.

A suggestion concerning scientific work, by WILLIAM R. DUDLEY.

As economic interests largely determine the direction of scientific research in this country, it is well to bear in mind that the fresh-water algæ, up to the present time almost entirely neglected, hold an important place in sanitary matters, and are therefore entitled both from a scientific and an economic stand-point to more attention from investigators.

Notes on seedlings of Elymus Virginicus, by W. J. BEAL.

Notes on bird's-eye maple, by W. J. BEAL.

These papers were illustrated, especially the latter, with many excellent and interesting specimens. Various forms of bird's-eye markings were described, both in the maple and other kinds of woods. Tracing them back to their earliest stages did not reveal anything regarding the inciting cause or causes.

Notes upon stamens of Solanaceæ, by BYRON D. HALSTED.

Solanaceous stamens have three modes of dehiscence, and in other ways show much diversity, but one character appears to be general and limited to the order. This is the presence of a cone or "columella" in each theca. Apparent exceptions will be met with in examining mature stamens, as in Datura, which, however, find explanation in the early stages of growth. This character in connection with measurement of the pollen furnishes valuable aids in classification of the members of the order.

Reserve food substances in twigs, by BYRON D. HALSTED.

The details of the observations have been given in Bulletin No. 4 of the Iowa Agric. Exper. Station. He concludes that a deposition of starch is an indication of maturity, and only indirectly of the hardiness of the plant. Grit due to the lignification of the pith cells in pear, apple, etc., is associated with the deposition of starch.

A bacterial disease of carnations, by J. C. ARTHUR.

The disease appears to be wide spread, but its characters were not heretofore well defined. It shows most prominently in a gradual dying of the leaves and general weakening

of the plant. The points of attack are easily visible in the early stages of the disease, as transparent spots when viewed by strong transmitted light. A Micrococcus, pure cultures of which were shown, has been demonstrated to be the cause of the disease, by direct artificial infection.

Grasses of Roane Mountain, by F. LAMSON SCRIBNER.

Published in full in another part of this journal.

Revision of the United States species of Fuirena, by FRED. V. COVILLE.

Three species are admitted: *F. scirpoidea* Michx., *simplex* Vahl, and *squarrosa* Michx., and vars. *hispida* Chapm. and *pumila* Torr. of the last species. These can be distinguished by the perianth scales and bristles.

A bacterial disease of Indian corn, by T. J. BURRILL.

Has been known some time, but its nature not recognized until recently. The plants have a yellowish and dwarfed appearance, with exudation near the ground. The bacteria have been cultivated.

An observation on Calamintha Nuttallii, DAVID F. DAY.

The first flower is apical and contains five nutlets instead of the usual four. This appears to be a step toward the peloric condition.

Fermentation of ensilage, by T. J. BURRILL.

The temperature usually rises during the fermentation of ensilage to a point (60° C.) that stops most if not all growth except that of a single species of bacteria. As the temperature falls secondary changes occur, especially the formation of lactic and acetic acids.

Modern teaching appliances in biology, by R. R. WRIGHT.

Professor Wright took this occasion to show and explain the various rooms and fittings of the new and handsome biological building in which the meetings of the section were held. All the appointments show much thought, and wise and liberal expenditure. Among the botanical appliances were Brendel and Auzoux models, Kny and Dodel-Port charts, Noll's growth apparatus, and three patterns of Leitz microscopes. In the upper story were conservatories and tanks for water plants built of granilitic cement.

On a convenient method of subjecting living cells to coloring agents, by GEORGE L. GOODALE.

Read by title.

The following paleobotanic paper was read before the Geological Section:

On certain remarkable new fossil plants from the Erian

and Carboniferous, and on the characters and affinities of the Paleozoic gymnosperms, by Sir WILLIAM DAWSON.

The paper was based upon material recently discovered. Stem, leaves and fruit from the Erian of Pennsylvania serve to establish a new genus and species, Dictyocordaites Lacoi, and other unusually perfect material from the same State and from Prince Edward island enable the author to clear up several obscure points in relationship.

The Botanical Club of the A. A. A. S.

It has been the custom of the club from its inception, with possibly an interruption at the Cleveland meeting, to hold its first session on Thursday, the second day of the association. This year did not prove an exception, although both the permanent secretary of the association, in his annual circular, and the secretary of the club, in a special circular, announced the first meeting for Tuesday, the day before the opening of the association. There are good reasons why the opening session should be on Wednesday, but it is doubtful if an earlier date will ever be found practical.

THURSDAY, AUGUST 29.—Shortly after 9 A. M. the president, Dr. T. J. Burrill, called the club to order, the secretary, Dr. Douglas H. Campbell, and a fair number of members being present.

The opening paper was by Mr. Thomas Meehan, who described the arrangement of stamens and pistils in Hypericum Canadense, showing that the styles are entangled among the stamens from the first, and claiming this to be an arrangement for self-fertilization. Dr. E. L. Sturtevant spoke of the self-fertilization of the common garden pea, and of the failure of the English bean (Faba vulgaris) to produce many pods in American gardens, although flowering freely. Mr. David F. Day had observed that the rose acacia (Robinia hispida) bloomed freely about Buffalo, N. Y., but set few pods, and examination had shown little pollen in the anthers. He also stated that the garden variety of Œnothera biennis expands its flowers with pollen already deposited on the stigmas. Mr. F. V. Coville said that Lupinus perennis also discharges pollen in the bud, but that in this case the stigma is not at the time in a receptive condition. Dr. B. D. Halsted, in his examinations of the garden pea, had found no germinating pollen

before the flower had opened. He had experimented with barberry by covering the flowers before opening, and had obtained fruit in only about three cases in a hundred, and possibly then only through defective protection. The pollen was there, but needed insects to elevate it to the stigmas. Dr. T. J. Burrill suggested similar tests with Hypericum. Dr. W. J. Beal thought it important to note the effect upon the stock of early and late fertilization.

Mr. Meehan also read a paper on the cleistogamy of Cerastium nutans. All specimens in the Philadelphia herbarium, wherever from, appeared to be cleistogamous, as well as the plants growing about the city. Similar observations had been made by Judge Day at Buffalo, and Mr. C. F. Wheeler in Michigan. Dr. N. L. Britton spoke of the frequency of apetaly in the Caryophyllaceæ, but thought cleistogamy almost unknown. Mr. Coville had noticed that Draba verna was cleistogamous during winter in the south.

Dr. B. D. Halsted read a paper on the pollen of Pontederia cordata, which is printed in full on another page.

Dr. Halsted also described the explosiveness of the pods of the wild bean, Phaseolus diversifolius, explaining the mechanism by which it is brought about. Dr. Britton said that many other species of the genus, and especially the tropical ones, expel the seeds in the same manner. He also called attention to the fact that this plant is really P. helvolus of Linnæus, the two names being interchanged in the manuals. Mr. M. B. Waite described the projection of seeds from the pods of native violets.

Dr. Britton showed herbarium specimens of quite a number of additions to the North American flora, and made interesting remarks in relation to them.

A collection of fifty-four well prepared cultures of bacteria and moulds on agar-agar, made by Dr. Roswell Park, of Buffalo, was exhibited to the club.

Friday, August 30.—Mr. Coville read a report from the Botanical Division of the U. S. Department of Agriculture, which was referred to a committee, consisting of Messrs. Burrill, Day and Macoun. Remarks complimentary to the department were made by Drs. Burrill, Britton and others. Mr. Macoun spoke of the botanical work being done by the Canadian survey, of the fraternal feeling of Canadian botanists for those of the United States, and of their willingness to supply material to any American scientists who may be working up special orders or groups.

Dr. Britton read a paper on the occurrence of a Siberian Labiate in Canada, and exhibited dried specimens of it. The plant is *Elsholtzia cristata* Willd., and was collected by Dr. John J. Northrop on the shore of Lake Notre Dame, province of Quebec, in 1887 and 1889. It appears like an indigenous plant in its habit of growth and persistence, but is supposed to have been introduced in wheat.

Dr. Britton also spoke of the trip of Dr. Morong in South America and its expected results in adding greatly to our knowledge of the little known flora of Paraguay. Drs. Burrill and Campbell were appointed a committee to draft a resolution expressing the interest of the club in Dr. Morong's labors.

Dr. W. J. Beal gave a description of the fruiting of Mesocarpus (Pleurocarpus) from collections made at Lansing, Mich., showing both lateral and scalariform conjugation on the same plants. As this is the principal character separating the two genera, the observation appears to remove all doubt that the latter genus should be merged in the former, a change that has already been suggested. The discussion was chiefly on the significance of conjugation in general. Dr. Burrill spoke especially of the so-called conjugation of the secondary spores of Tilletia. Dr. Bessey thought this might be an obsolescent sexual act on an obsolescent mycelium. Dr. Campbell said the essential part of the sexual act is the copulation of the nuclei, already demonstrated in some Zygnemaceæ and other lower orders, and abundantly in the higher ones.

Dr. Douglas H. Campbell called attention to the chlorophyll in the embryo of Celastrus scandens, exhibiting specimens, as illustrating the formation of chlorophyll in comparative darkness. Dr. Britton alluded to the similar case of chlorophyll in the pith of Phoradendron. He also said that he had seen a Lima bean plant grown by a workman on one of the lower levels of the Dickinson iron mine in New Jersey which had reached full eight feet in height and had an abundance of chlorophyll, although its only light came from candles.

Dr. Campbell then described his methods of obtaining and staining the pollen mother-cells of Podophyllum and Allium to show nuclear division. He also spoke of the ease with which he had grown aquatic plants in the laboratory for class use by using large glass jars and only occasionally changing the water. This evoked quite an animated discus-

sion, the experience of the members of the club being quite diversified, there having been more failures apparently than successes.

Dr. J. C. Arthur described the arrangement of curtains in his laboratory, by which he considered that he had secured a better and more efficient lighting with a south exposure than is possible when the light is admitted from any other direction.

MONDAY, September 2.—As many as half the members of the club were absent on the excursion to the Muskoka lakes, but the usual meeting was held at 9 A. M. in the biological room, Prof. Bessey acting as president and Prof. Arthur as secretary *pro tem.*

The treasurer's report was read, showing a deficit of over four dollars. After some discussion it was laid on the table for subsequent action.

Mrs. Henrietta L. T. Wolcott desired to learn if the amber-colored choke-cherry occurred in Canada, as she had been told that it did. She reported the destruction, during some street improvements, of the original trees with amber-colored fruit in Dedham, Mass., which the club had heard about at former meetings, and which Dr. Sereno Watson had thought worthy of being described as a distinct variety. No one was able to give the information desired, but it was the opinion, especially of Mr. Macoun, that no such variety was known to exist in Canada.

Mr. W. H. Seaman exhibited a number of species of interesting plants gathered in the vicinity of Toronto, and also a convenient portable plant press. Quite an extended discussion arose on different forms of presses and methods of collecting. Mr. Macoun said that he and his son together had collected as many as 20,000 specimens in a season in connection with the Canadian survey. They use presses with board sides and stout straps, containing about twenty sheets of the usual drying papers. To secure good specimens in wet weather, when in camp, the dryers are held before the camp fire one by one until a pile of hot dryers is secured to which the plants are transferred from the hand press. Other papers are similarly heated, and the plants again transferred. Usually three transfers are enough to fully dry all but the thickest specimens, so that the plants collected in the forenoon may be dried during the afternoon.

The members who participated in the excursion to the lakes met at the usual hour of 9 A. M. in the upper cabin of

the steamer Nipissing on Lake Rosseau, and were called to order by the president, Dr. Burrill. In the absence of the secretary, that office was temporarily bestowed on Mr. Henry Farquhar.

Mr. Meehan reported observations on the development of the inflorescence of Corydalis sempervirens, in which the middle flowers appear first, then those above and below alternately. The discussion showed that similar behavior had been observed in other members of the same order and in the Dipsaceæ.

The vegetation of the Muskoka lakes was discussed at considerable length, specimens exhibited and several puzzling forms described. On motion of Mr. Day, Dr. Britton was appointed to prepare and publish in the *Bulletin of the Torrey Club* as complete an account as possible of the flora of the lakes.

TUESDAY, September 3.—The usual meeting was held at 9 o'clock with Dr. Burrill in the chair, and with Dr. Arthur still acting as secretary *pro tem.*

A committee on the nomination of officers for the ensuing year was appointed to consist of Messrs Day, Bessey and Coville.

The treasurer's report was then taken from the table and after some discussion was accepted. Voluntary subscriptions were then offered, amounting to $11.50, which not only canceled the indebtedness of the society, but left enough in the treasury to meet the preliminary expenses for the coming year.

The desirability of having a permanent record of the proceedings of the club in a convenient form was discussed, and it was the general opinion that such should be entered in the volume that had been procured for the purpose in compliance with the action of the club at the Cleveland meeting. The accounts as published in the *Bulletin of the Torrey Club* and the GAZETTE could be used as the basis for the previous years.

The committee appointed Friday to consider the report from the Botanical Division of the Department of Agriculture offered the following, which was heartily adopted by the club:

Having been informed of the active and encouraging work of the Botanical Division of the United States Department of Agriculture, we take great pleasure in expressing our high appreciation of the important work already accomplished and in the extensive undertakings in progress. The recognition by Congress of the importance of this botanical work, manifested by liberal appropriations of money, make possible, for

the first time in America, adequate scientific and practical researches upon native and introduced plants—in health and disease—upon which the wealth of the country so largely depends, and in which is centered the highest educational and æsthetical interests.

We heartily commend the management of this botanical division and section of vegetable pathology by those now in charge, and cheerfully express our readiness to aid them in any and every possible way.

T. J. BURRILL,
DAVID F. DAY,
Committee.

A paper was read by Prof. Joseph F. James on the value of color as a character in classification. He gave examples of its employment in such cases as Impatiens pallida and fulva, Melilotus officinalis and alba, Datura Stramonium and Tatula, Morus rubra and alba. Odor is also sometimes an important character. Dr. Britton made confirmatory remarks.

The officers for the coming year were then elected in accordance with the report of the nominating committee, as follows: President, Dr. N. L. Britton, of Columbia College; Vice-President, Prof. F. L. Scribner, of University of Tennessee; Secretary and Treasurer, Dr. Charles R. Barnes, of University of Wisconsin.

Mr. W. M. Beauchamp reported an acknowledgment from Mrs. Gray in reply to the resolutions passed by the club at the Cleveland meeting on the death of Dr. Gray.

Mr. Coville made a report on the present condition of the Botanical Exchange Club. There are twenty members. Of the forty dollars received as membership fees, there remains, after paying for printing, postage and other necessary expenses, a balance of $14.76. A considerable saving might be effected if the privilege of using the government frank could be secured in forwarding the return packages. 3,260 specimens have been received from members and 1,295 sent in return, leaving more than half still on hand. Printed copies of the rules were distributed.

The following committee report was then read and most heartily adopted:

Your committee appointed to make some expression of the interest taken by members of this club in the South American collecting trip of Dr. Thomas Morong beg leave to report as follows:

Resolved, That the compliments of the A. A. A. S. Botanical Club be sent to Dr. Thomas Morong, now making botanical collections in unexplored regions of South America, and that we tender to him an expression of our warmest interest in, and heartiest appreciation of, his arduous but highly promising labors in the new fields of his choice. We sincerely hope he may in due time return with health and strength, burdened only

by abundant success and large contributions to the known flora of the world.

T. J. BURRILL,
DOUGLAS H. CAMPBELL,
Committee.

A committee, consisting of Messrs. Britton, Seaman and James, was appointed to draft resolutions in recognition of the courtesies received from the local committee.

The hour for the sectional meeting having now arrived, the club adjourned until the close of the morning session of the biological section.

The adjourned session was necessarily short, and time was taken only to hear the following resolutions:

WHEREAS, The Botanical Club of the American Association for the Advancement of Science having been most cordially and generously entertained by the citizens of Toronto; and

WHEREAS, The excursions tendered by the local committee of Toronto to the members of the association have been especially enjoyed by the botanical members thereof, who have been thereby enabled to visit points of botanical interest; therefore, be it

Resolved, That the Botanical Club extend their hearty thanks to the local committee for the arrangements made for their comfort and pleasure during the meeting for 1889.

WM. H. SEAMAN,
N. L. BRITTON,
JOS. F. JAMES,
Committee.

Resolved, That the Botanical Club of the A. A. A. S. notes with great pleasure the liberality shown by the Canadian government in providing the admirable new building and equipment for the Biological Department of the University of Toronto, and ventures to hope that at an early day the facilities here provided may be extended to include a suitable botanic garden, to which end the members of the Botanical Club pledge such assistance as may lie in their power.

Both resolutions were warmly adopted, and the club adjourned.

The sessions of the club proved much too short to hear all the papers and discuss the subjects which the members desired to bring before it, and several valuable papers were not reached.

EDITORIAL.

It was a prominent motive with the founders of the Botanical Club to make it an instrument in expanding and elevating the botanical thought of the American Association for the Advancement of Science as expressed in the papers presented before it and in the selection of botanical enterprises which it desires to foster. It was believed that if this could be accomplished to any extent, the influence would be felt in rais-

ing the standard of American botanical science as a whole. The means relied upon for accomplishing this object were (1) to create a greater feeling of fraternity among botanists and thus induce more of them to attend the meetings, (2) to make the sessions quite informal, so that every one in attendance would feel unembarrassed and at liberty to offer any bit of information that he might think of interest to his fellow workers, (3) to provide an audience for hearing such papers as are worthy of record, but because of their brevity or the relative unimportance of their conclusions would add nothing to the dignity or value of the proceedings of the biological section of the association, (4) to scrupulously refrain from permitting the club in any way to occupy or trespass upon the time or the interests rightfully belonging to the association, and (5) to keep the club intimately but unofficially connected with the association and allow no independent organization. The lines on which the club was established have been very well maintained, and the opinion of members of the association, whether botanists or not, goes to show that it has exerted a considerable influence and been reasonably successful in its aims. It is in this very element of success, in fact, that the danger to the club lies. It seems to be the common opinion outside of the club, and, we regret to say, is held by some botanists as well, that the club, having become so strong, will eventually form a section of the association. It seems to us that those holding such views do not rightly appreciate what the club is attempting to do. The idea of transforming such an excellent lever for accomplishing a good purpose into the thing to be elevated, ought to require no argument to show its want of wisdom. This journal gave some suggestions relative to the sphere of the club, in its editorial on the same subject a year ago, which it is not necessary to repeat here, although they might profitably be borne in mind by those who help in shaping the botanical features of the programme for the meetings of both the club and the association.

NOTES AND NEWS.

THE AMERICAN ASSOCIATION meets next year at Indianapolis on the third Wednesday in August.

PROF. DR. SADEBECK has been entrusted with the administration of the Botanical Gardens at Hamburg, vice Prof. Reichenbach, deceased.

PROF. DR. K. PRANTL, of Aschaffenburg, has been nominated as the successor of Prof. Dr. Engler as Professor of Botany and Director of the Botanical Gardens of the University of Bresleau.

PROF. A. J. COOK, concludes from observation and experiment that honey is digested nectar, that when bees gather nectar very rapidly, however, some of it fails to be digested. Honey taken under such circumstances will show right hand rotation from the presence of unchanged sucrose.

MISS SUSAN M. HALLOWELL, of Wellesley College, notes and illustrates in the *American Florist* for October 1, an interesting variation in a calla (Richardia) in which a pure white but otherwise normal leaf arises from the pedicel just below and opposite the true spathe, giving the appearance of a double spathe.

THE COMMON cultivated grasses do not grow well upon the virgin soil of Nebraska, according to Prof. Bessey, but timothy (Phleum pratense) succeeds after a few years of preliminary tillage, and is the grass mostly grown, while Kentucky blue-grass also does well if a still longer interval of previous cultivation is allowed.

IN THE CELL produced directly by the zoospores of Synchytrium Taraxici the nucleus has been found of a diameter of 14μ, and the nucleolus 8μ. Shortly after this size has been attained division commences, resulting in the production of from 150 to 300 nuclei in the one cell. So says M. Dangeard, *Comptes Rendus*, cix, 1889, 202.

PROFESSOR GEORGE L. GOODALE, of Harvard University, is president of the A. A. A. S. for 1890. This is the second time in the history of the society that a botanist has filled the president's chair. Dr. Gray was the first recipient of the honor, in 1871. The vice-president of the biological section for 1890 is Dr. C. S. Minot, and the secretary, Dr. J. M. Coulter.

THE TOTAL NUMBER of papers presented at the Toronto meeting of the A. A. A. S. was 228, of which 34 came before the biological section. Twenty-two of the papers in biology were botanical, or 65 per cent., and the remaining 12 were mainly entomological. Zoölogy proper made a comparatively small showing. One might inquire if this mathematical relationship is not correlated in some manner with the establishment of biological clubs.

THE OFFICERS for the coming year of the Society for the Promotion of Agricultural Science are Prof. C. E. Bessey, of University of Nebraska, for president; Prof. W. R. Lazenby, of Ohio University, for secretary and treasurer; and Prof. T. J. Burrill, of Illinois University, for third member of the council. Thus all the officers of the society have inadvertently been filled with botanists. It is also a notable fact that one-fourth the members of the society are also botanists.

M. A. GIARD notes in the *Comptes Rendus* (cix, 1889, 324) an instance of the sterility (castration parasitaire) in Hypericum perforatum, due to the attacks of *Cecidomya hyperici* Bremi and *Erysiphe Martii* Lév. The most interesting feature of this parasitism, however, is that the insect and the fungus both produce profound changes in the general aspect of the plant, but the induced *facies* are absolutely unlike. The normal form of this species is that of an inverted cone, the lower branches being elongated and forming with the main axis a large compound corymb of flowers. Under the action of the Erysiphe, all the branches are abortive or rudimentary; the principal stem bears a few flowers, which mostly are sterile, but the leaves are very much larger than in the normal state and of a deeper green. Under the influence of the Cecidomya the form becomes that of an erect cone, the leaves become narrow, almost linear, colored externally like fruits, the parenchyma thickens, and at the edges are formed numerous black glandular points identical with those on the margins of the petals. The form thus produced resembles strongly the variety described by Jordan under the name H. microphyllum.

SAPOSCHNIKOFF finds[4] that sugar can be transformed by the leaves into starch. In his experiments he placed plants of various sorts in the dark for a time, then cut off some leaves and bisected each along the midrib. One-half was tested for starch, the other was laid for 4–18 days in a 10–20 per cent. solution of cane sugar, and then tested for starch both with iodine and by Faulenbach's method. Starch was found in abundance, especially along the veins. When the lower end of a leaf of Cordyline rubra was dipped 5 mm. in the sugar the leaf was black under the iodine test as far as 7 mm., from which point up to 10 mm. the color gradually became less deep, but extended far along the veins. In variegated leaves only the chlorophyllous cells formed starch.

THOSE who have used the paraffin imbedding method for serial sections (see this journal for January, 1888) have doubtless wished for some simplification of the process of staining. This may be done, according to Dr. Kükenthal, by dissolving the coloring matter in absolute alcohol and dropping the solution into turpentine until the desired depth of color is secured. Sections fixed to the slide with the collodion are kept in the oven until the clove oil has completely evaporated, the paraffin dissolved in turpentine as usual, and the slide brought into the dye. The staining is quickly effected. Overstaining may be corrected by placing the slide for a short time in a mixture of acid-free absolute alcohol and turpentine (equal parts?). Turbidity of the coloring fluid may be corrected by adding a drop or two of alcohol. Meyer's carmine, methyl green, methyl-blue, gentian-violet, safranin, Bismarck-brown, eosin, fuchsin, tropæolin and malachite-green may be used in the above way.

THE SOCIETY for the Promotion of Agricultural Science held its tenth annual meeting at Toronto, August 27 and 28. Twenty-five papers were presented, of which the following are of botanical interest: J. C. Arthur, "What is common wheat rust?" the conclusion being reached that the most abundant and damaging rust of this country is not Puccinia graminis, as usually assumed, but P. rubigo-vera; W. J. Beal, "A study of bird's-eye maple," specimens of wood from maple and other trees being shown to illustrate various appearances and peculiarities of this malformation, but no conclusion regarding the cause arrived at, also "Wild grasses under cultivation," giving the result of raising the glaucous form of Elymus Virginicus from seed, only two plants out of four hundred reverting to the non-glaucous form; C. E. Bessey, "The grass problem in Nebraska," giving an account of the distribution and economic value of the most prominent native grasses, and the success attained in introducing the cultivated ones; T. J. Burrill, "A bacterial disease of Indian corn," describing an important disease chiefly affecting the roots and lower internodes; F. L. Scribner, "Grasses of mountain meadows and deer parks," among which species of Danthonia were considered the most important economically. Several other papers contained more or less botanical matter, among which were the following: Manly Miles illustrated a paper on soil metabolism by showing test-tubes said to have been etched by soil bacteria grown in nutrient material without potash; M. A. Scovell gave an account of experiments with potatoes in which blighting of the foliage was prevented by use of potash salts upon soil previously deficient in potash, the kind of blight not determined; William Saunders spoke of the comparative yield of varieties of wheat, considering each plant in the experiment individually; C. M. Weed described the treatment of potatoes with Bordeaux mixture, successfully checking the blight

[4]Berichte. d. D. bot. Gesells., vii. 258.

(Phytophthora) with four applications of half strength solution; H. W. Wiley gave analyses of sorghum seed and spoke of its comparative food value, and also of the nature of the red coloring matter of the seed and glumes. Two papers by B. D. Halsted, "The cranberry gall fungus" and "Our worst weeds," were read by title only.

IT HAS PROVED a difficult task to settle experimentally the place of the transpiration stream in plants, particularly in the herbaceous dicots and the monocots. Long ago the experiment of "ringing" the trunk of the woody plants determined that it was either in the wood body or pith that the water was conducted, and reasoning showed pretty conclusively that the pith could not have anything to do with this work. But recently Hartig and Wieler have differed widely as to what parts of the wood were most active in conduction. A long step forward in the experimental work on this function has been made by Bokorny[1] in hitting upon the use of iron sulphate. For a long time various liquids have been used in the endeavor to ascertain the rate of the transpiration stream; at first coloring matters in solution, and later salts of lithium. The difficulty with the latter is that while they can be easily detected spectroscopically in any region of the plant, it is not practicable to detect them in a tissue nor to discern whether they are in the walls or the lumen. Iron sulphate possesses the three necessary qualities of not being seized upon by any particular part of the plant, of not injuring the cells and of being easily recognized *in loco* by a simple microchemical reaction. It is used in the proportion of 1:500 or 1:1000 of distilled water, and its presence in any tissue can be detected by the use of a watery solution of ferricyanide of potassium (1:10). In general, Bokorny's results agree with the statements of Sachs (Cf. Vorlesungen über Pfl.-Phys.) except in the important particular that often tissues that are not lignified (e. g., epidermis, collenchyma, soft bast) are water-conducting, so that Sachs' insistence upon the lignification of the walls as the reason of their permeability falls to the ground. Whether in woody plants or herbs, it is the vascular bundle chiefly in which the water travels, though in some collenchyma and sclerenchyma are also conducting. In the vascular bundles it is chiefly the xylem which carries the water, sometimes the thin-walled bast. In all cases the water goes in the wall, and not in the lumen of the cell.

LEO LESQUEREUX, our most eminent bryologist and palæo-botanist, died at his home in Columbus, Ohio, on Friday, October 25th, aged almost eighty-nine years. Some years ago failing sight compelled him to give up his bryological studies, and his strength has been gradually failing. We hope to give a further account of his life and works in our next number.

[1] Biologisches Centralblatt, ix, 1889, p. 289; Ueber den Ort der Wasserleitung in den Pflanzen.